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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

In The Matter Of:

Amendment of the commission's Rules to Establish New Personal Communications Services	)))))))	GEN. Docket No. 90-314 ET Docket No. 92-100 RM-7140, RM-7175, RM-7617 RM-7618, RM-7760, RM-7782 RM-7860, RM-7977, RM-7978 RM-7979, RM-7980

To: The Commission

COMMENTS OF OMNIPOINT COMMUNICATIONS, INC.

November 9, 1992

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COMMENTS OF OMNIPOINT COMMUNICATIONS, INC.

OVERVIEW

Personal Communications Services (PCS) present the opportunity to introduce an extraordinary new breadth of wireless, mobile, voice, data, and video services and greatly expand the number of people who can afford to pay for these services. PCS can offer competition to cellular and the LEC as well as offer complementary services to those infrastructures. Yet the hurdles facing the successful introduction of PCS are unparalleled. The capital, competitive, and "political" challenges resemble perhaps only the non-monopoly period of the telephone industry 100 years also in terms of relative difficulty and opportunity for new entrants. The technical issues, however, are unprecedented.

All of the major licensing issues on which the Commission has requested comments -- amount of spectrum, number of operators, size of territory, "universality", restriction on participation -- must be discussed within the context of three overwhelming facts:

1) PCS will have to be migrated into a band currently occupied by roughly 10,000 microwave links that will permanently have either primary or co-primary status.

This technical requirement to migrate into the 1850-1990Mhz band on a coexistence basis will dictate the real world consequences of any other PCS licensing regulation. As will be shown below, the ramifications of this defacto sharing requirement on PCS will dwarf all the political arguments regarding how much spectrum, how many operators, etc. For PCS to compete with cellular and the wireline -- both of which have national standards, multiple providers of low cost equipment, and clear "bandwidth" -- the PCS licensing process must be willing to recognize the technical realities of launching PCS and be open to creative spectrum solutions like those which will be suggested below.

2) For PCS to offer services different from cellular, there must be more bandwidth available per new PCS operator than the 25Mhz allocated for cellular. Whether and under what terms cellular providers can also obtain PCS licenses at 1850-1990Mhz is a separate issue. But as will be shown, without more bandwidth, new PCS entrants will be forced to follow the same economics as cellular, which will result in no new services for the consumer.

3) For PCS to offer wireless services at lower per minute costs and lower handset costs than cellular, PCS must be launched with a different network architecture and one that will require massive up-front capital costs. Cellular is based on a low risk capital infrastructure, minimizing the initial capital costs through the use of large cells. The tradeoff is that they

have a high marginal and average cost of capacity, and require expensive, short talk time, handsets. This early choice of infrastructures will keep the effective per minute charges for cellular unnecessarily high.

PCS, if deployed differently, offers a one time opportunity for the consumer to gain wireless access to wireline quality voice and data services at costs that will resemble the wireline network. However, to achieve this, investors must be able to see the rewards of financing a network that is primarily fixed cost in nature. More than two PCS licenses per territory will cause PCS to retreat to the same architecture as cellular.

CAN PCS BE DIFFERENT FROM CELLULAR?

As the PCS industry approaches the beginning of its 5th year of discussions, it is worth asking if new PCS licensees could offer anything that the cellular industry would not implicitly have an advantage in providing itself. Recall how differently cellular was viewed in 1988 just before Lord Young, as Chairman of the U.K.'s Department of Communications, issued his famous January 1989 white paper titled "People on the Move" which first described "personal communication networks".

At that time, cellular was still viewed as a car oriented, voice only, service. Cell radii had started at almost 20 miles in many locations, covering more than 1200 square miles from a single site, and offering only 55 channels over that immense territory. Capacity limits were viewed as a "wall" by the industry, and the limits and cost of analog were seen as grinding growth to a halt. One of the most widely read industry forecasters had predicted fairly accurately in 1986 that cellular would grow more than 50% and hit 1 million subscribers by the end 1987, but then forecasted that it would take 3 years to cross the 2 million mark. Handheld cellular phones were still considered something of a technological marvel, cost $2000, were owned by at most 90 thousand people in the U.S., and were affectionately referred to as "bricks".

Today cellular has 10 million subscribers. It is growing at a pace that is adding nearly 3 million subscribers per year. That one year growth alone is 150% of the size of the <u>cumulative</u> installed base of cellular customers when the PCS discussions began. In major U.S. markets 50-90% of the sales are handhelds, with 6 ounce pocket phones now available. Car phones are often given away with new subscriptions. Cells in Manhattan average half a mile in radius, offering 1600 times the capacity per square mile as cellular's original radii. The vendors to the cellular industry are promising that the introduction of digital will foster a new era in wireless computing and increase voice capacity by as much as 40 times yet again. By implication, this would support 400 million subscribers at current usage patterns. Some cellular operators now even offer subscribers a single number which will "follow" them anywhere, thus introducing the "personal" feature of PCS.

It can be no wonder that AT&T announced its intent to provide PCS by acquiring initially 33%, and eventually control, of McCaw, the only near national cellular operator.

Given the apparent extraordinary advantages which cellular operators have in providing PCS, the Commission must ask itself how it intends to foster competition and why. In fact, if cellular has the capacity to eventually service every man, woman, and child two times over, why license any new spectrum?

Why Competition?

First, only 4% of the population has a wireless, mobile, telecommunications device, <u>and only 1% of the population has a handheld</u>. The reason is price. Many pocket phones list for well over $1000, though the subsidized cost for new subscribers is averaging roughly $500 for handhelds.

The real sticker shock results from the real price per minute. Effective average industry charges for cellular are roughly 55 cents/minute versus 2 cents/minute for wireline access to the PSTN, when the subscription fees are included. For low usage cellular subscribers the cost is roughly 93 cents/minute.

Second, 24% of the cumulative <u>installed</u> base drops their cellular service <u>every year</u>. What other industry has such a high rejection ratio?

Third, new subscribers' loaded costs per minute of actual usage are increasing. Although average revenue per subscriber is declining, minutes per use per subscriber is declining faster. Virtually all industry forecasts presume cellular's true per minute prices will go up at the same time that their costs per minute are declining. Kagan Associates, Inc., for example, forecasts that service revenue will rise from 53 cents/minute in 1991 to 71 cents/minute by 2003, or an increase of 35%. For the new low usage customers, Kagan is forecasting a rise to $1.53/minute.

Fourth, the current phones offer no privacy and the lighter phones offer little more than half an hour of talk time before requiring recharging. It requires major investment in infrastructure and digital technology to change this.

Fifth, unlike their would be competitors, the cellular operators appear unwilling to make the infrastructure investment to allow a true digital alternative which would provide privacy and longer talk times <u>at a lower cost to the user</u>. In order to save on infrastructure costs, the cellular operators will "phase-in" digital in a way that raises the cost to the consumer. Digital cellular phones will have to be dual mode (ie, capable of using analog cell site channels) or else they won't necessarily work in every cell. However, dual mode analog/digital phones are inherently heavier and more expensive.

Sixth, the primary reason for cellular operators to go digital in the near term is to increase the number of voice channels per square mile at a lower infrastructure cost than is achievable through more cell splitting. To do this, however, requires using extensive voice compression techniques. (Initially 8kbps and then 4Kbps vs 32Kbps for wireline quality). As good as these techniques are, they do not provide wireline quality voice acceptable as a replacement for current office and residential wired phones.

Seventh, with the conversion of cellular to digital, the <u>data</u> rates available per user are going the wrong direction. In order to service their voice customers capacity demands with the lowest infrastructure costs, the cellular industry is planning to use ever lower vocoder rates. This has the effect of constantly reducing the channel rate available per user for data applications. Further, the cellular network is designed for voice only and is a circuit switched rather than a packet switched network, thus placing huge overheads on most data oriented applications. The current proposals for offering packet switched services are still designed to provide only low per user data rates. Moreover, they either require the user to carry a different device for their data needs, or to share a very small number of relatively low capacity data channels across all users in a cell.

In summary, the three primary reasons for fostering competition are:

1) to drive true per minute usage costs and handset prices down,

2) to increase the number of people who can afford the benefits of PCS by a factor of 40, and

3) most importantly, to offer new and better wireless services

THE <u>NEW</u> SERVICES WHICH <u>NEW</u> PCS LICENSES CAN OFFER AND THE REGULATORY REQUIREMENTS FOR PROVIDING THEM

As noted above, cellular's advantages and market lead in providing wireless, mobile, telephony are enormous by comparison to a new entrant. Yet equally obvious is the opportunity to introduce new and different products and services, and to lower the cost of usage. However, for new PCS entrants to do that requires more bandwidth than cellular and massive up-front infrastructure investments. Without the necessary bandwidth and the incentives to investors to risk large initial capital outlays, the new competitors will simply clone cellular's technical architecture at the higher frequencies. If this happens, PCS operators will have no way to differentiate themselves and they will offer no advantages to the consumer.

The 100 Million Subscriber Market

Wireless telephony is already a mass consumer market. Since their introduction in the early 1980's, more than 60 million home cordless phones have been sold. For PCS to go from its current incarnation as a handheld, analog, cellular phone at less than 1% penetration to its 100 million user potential when wireless pocket, digital, communicators can be carried anywhere, and used for residential and business communications, as well as mobile communications, several major product and infrastructure changes must be made.

What Lightweight, Long Talk Time, <u>Wireline</u> Voice Requires

It is sometimes stated that PCS should not need as much spectrum as cellular since it can be all digital while cellular will remain "stuck" with analog. <u>It is not the conversion from analog to digital which increases capacity but rather the use of voice compression</u>. Unfortunately, voice compression must remove information, thereby partially diminishing the quality of reproduction. It also increases the distortion due to the inevitable bit error rates of RF. For PCS <u>to allow the use of a single handset for both outdoor mobile use as well as a private premises alternative to the users wired phone, then wireline quality vocoders and compression algorithms must be used</u>.

At best, such wireline quality vocoders only match analog from a capacity perspective before other techniques such as spread spectrum are used. DECT and CT2 required 32Kbps in order to offer wireline quality voice, and both require significantly more RF bandwidth per user than analog cellular (100Khz for CT2, 148Khz for DECT, versus 60Khz for analog cellular, all full duplex.)

Taken in isolation, wireline quality digital encoders require 4 to 8 times as much bandwidth as the low rate vocoders targeted by cellular. Some of this can be gained back through spread spectrum techniques, but to service large numbers of users will still require more bandwidth per PCS operator than cellular's 25Mhz.

One of the best technology-independent studies performed on determining spectrum requirements for PCS was produced by Telocator's PCS Technical and Engineering Committee in May 1992. Engineers from more than 20 companies representing many competitive technology approaches agreed on calculations estimating required spectrum for one, two, and three PCS operators to provide a variety of PCS services. Two of the models required wireline quality voice (ie 32Kbps). Assuming the availability of clear spectrum, the average of the conservative and optimistic spectrum estimates necessary to provide pedestrian and vehicular PCS service was:

ASSUMING CLEAR SPECTRUM

TELOCATOR'S AVERAGE SPECTRUM ESTIMATES FOR OUTDOOR PEDESTRIAN AND VEHICULAR PCS ONLY

	Two PCS Providers	Three PCS Providers
Total Spectrum	100.8Mhz	113.4Mhz
Per Operator	50.4Mhz	37.8Mhz

These estimates were based on an analysis which was independent of whether TDMA or CDMA was used, and whether narrowband or wideband channelization was employed. The full analysis was submitted earlier by Telocator. The results are presented here only to reinforce the point that wireline quality voice requires much more spectrum. Note: the conservative assumptions require <u>67Mhz per operator for two operators and 75.6Mhz per operator for the three operator scenario</u>.

These estimates, however, do not take into consideration a three dimensional frequency reuse problem such as would be encountered to provide PCS in-building. Nor do these estimates include any spectrum for wireless PBXes or residential service.

What 64Kbps Per User Data Rates On Demand Requires

For similar technical reasons to the requirements of providing wireline quality voice, the ability for the PCS operator to provide data rates on demand which are compatible with the computer and digitized video industry's needs (ie, 64Kbps per user) requires much greater bandwidth than cellular's 8kbps and 4Kbps per user goals. Even though these high data rates will only be required episodically or for bursts, the PCS over-the-air protocol as well as the PCS network protocol must be designed to provide this to a single device. The result is that more bandwidth is needed to offer these computer oriented services as compared to voice only or voice dominated services.

CONCLUSION: If PCS operators are not provided the ability to obtain at least 40Mhz of unimpeded spectrum, they will be forced to use essentially the same high compression vocoders planned for cellular in order to compete on capacity utilization, and the consumer will have no ability to obtain wireline quality voice in a digital pocket phone, nor wireline data rates on demand. The battery drain and cost will be higher, and the talk time lower, as a consequence of being forced to use high compression vocoders.

THE HIGH INFRASTRUCTURE COSTS OF PCS

The above spectrum estimates assumed cell spacing for vehicular PCS at only 1000 meters, and pedestrian PCS at 100 meters. Larger cell spacing would have required more spectrum to achieve the same capacities. These cell spacings are about as small as is economically and technically feasible. ***The good news is that the use of microcells will also allow the use of lower powered handsets, which will in turn allow them to be lighter, cheaper, and have four to eight hour talk times. The bad news is that to allow such handsets to be deployed from the beginning of the PCS services launch, all of the PCS cells must be relatively small.***

We estimate that some sites with low capacity requirements initially (and outside dense urban areas) might be able to use as large as three mile cell spacing while using handsets that met the above criteria. But if larger cells are used anywhere within the network, the handsets would have to be designed for these large cells, and would lose the above benefits.

The consequence of requiring such microcells in order to provide consumers with the benefits of lightweight, low cost, long talk time, wireline quality handsets is a staggering infrastructure requirement. Between 100 and 400 times as many cells have to be constructed on day one to cover the same area that one cell could during the cellular industry's start up. PCS will even require constructing more than four times the number of cell sites as the densest existing cellular system to achieve similar capacities using wireline quality service criteria in the same geographic areas. Clearly, this density of cell capacity is not practical for a start up using traditional cellular infrastructures.

CONCLUSION: Differentiated PCS -- i.e., with all the consumer benefits of lower costs and wireline quality cited above -- requires enormous up front infrastructure costs and new network architectures. For investors to justify risking the massive capital required for deploying wireline quality service wirelessly, they must be given a period of time when they are not facing disincentives to invest due to destructive competition. Each of the major markets will already have three competitors to PCS from the two cellular carriers and at least one ESMR operator. *Note that ESMR has already been forced to clone cellular's architecture due to ESMR's limited available bandwidth. More importantly, note that Fleet Call has stated that it has no intention of competing on price*. This is an inevitable result of the architecture and lack of bandwidth.

Even two PCS licensees per territory will provide the consumer with five choices. *But more than two PCS licensees will drive the PCS operators to also clone cellular's architecture in order to reduce the up front capital risks. This will result in consumers having only one more choice in network providers but no choice in new services or services with structurally lower costs*.

What PCS Requires to Lower Per Minute Usage Prices:

In the forecasts for cellular referred to above, they did not assume cellular's subscription or per minute charges rose. Rather they assumed that the newer subscribers chose to use fewer and fewer minutes, presumably due to their higher price sensitivity. In the year 2003, the typical new, low usage, subscriber is forecast to use his phone only 25 minutes per month. Since historically the duration of the average cellular call has stayed fairly constant at roughly 2.5 minutes/call, this implies that these new subscribers are only making an average of 10 calls per month. Contrast this with a typical wireline phone which is used today roughly 1000 minutes per month.

For consumers to be able to obtain low per minute pricing, new PCS operators must deploy a different type of infrastructure from that of cellular. The low per minute cost infrastructure is one where the marginal cost of adding a subscriber and additional minutes of usage is extremely small. Today, cellular's architecture has required a nearly linear average capital cost per subscriber of roughly $1200/sub, or

$20/month/sub using 5 year depreciation. More importantly, the average capital cost per minute of use has been rising since the average minutes of use per subscriber has been declining.

The only way to fundamentally change the cost of delivering minutes of service is to reject the high variable cost infrastructure of cellular in favor of a high fixed cost infrastructure which is designed to drive the marginal costs of capacity to those resembling the wireline network.

This low per minute cost network is achievable, but requires:

1) more bandwidth per operator than cellular; and

2) massive up front capital expenditures.

The ramifications of this are that PCS should have at least initially only two PCS operators per territory in order to attract the capital financing and at least 40Mhz in order to provide the capacity benefits of better trunking and to amortize across many more minutes of use per subscriber per geographic area.

THE RAMIFICATIONS OF DEPLOYING PCS IN SHARED SPECTRUM

Whether FDMA, TDMA, or CDMA techniques are proposed for use by a PCS operator, a primary requirement for coexistence with the OFS microwave users is to avoid operating in the beampaths of the OFS links. In and around all of the major cities, all of the 10Mhz channels in the 1850-1990Mhz band are in use. Further, within or near these cities each of the 10Mhz channels are reused 11 times on average by the OFS operators themselves.

<u>It is not technically possible for PCS to be deployed in the major cities on a noninterfering basis with OFS with only 20Mhz per PCS operator using any sharing technique</u>. A 20Mhz allocation per PCS operator, frequency duplexed by 80Mhz, is effectively an N=1 reuse scheme from the perspective of the OFS users. Regardless of how narrow or wide the PCS operator's channels are within the 10Mhz pair, the PCS operator would have no frequencies to be agile with from the perspective of attempting to avoid interference to the OFS users sharing that 10Mhz pair. PCS coverage patterns in a territory would resemble at best the holes in Swiss cheese in order to avoid all the OFS beampaths.

Unfortunately, the proposed 30Mhz, frequency duplexed PCS allocations, present a negotiating and interference attribution quagmire. Each of the PCS operators would have frequency boundaries that overlap halfway into multiple OFS operators' 10Mhz channels. Every cell site using those overlapping OFS channels would require a three way negotiation. If one PCS operator needs the frequency cleared more than the other, the second PCS operator would be advantaged by simply waiting and letting the first operator pick up all the expenses of relocation. One PCS operator may be willing to pay royalties to an incumbent OFS while the other only wants to relocate the OFS. Further, each PCS operator could try to blame any interference to an OFS user on the other's system.

CONCLUSION: PCS frequency allocations must be aligned with the existing OFS channelization scheme. Since 95% of the OFS licenses are for 10Mhz channels and there are no separate 5Mhz channels, only interstitials, PCS operators should only be allocated either 40 or 60Mhz.

40Mhz vs 60Mhz for Sharing

40Mhz of shared OFS spectrum is not even a little like 40Mhz of clear PCS spectrum. It is difficult to generalize the quantitative improvement in the ability for PCS to coexist due to having an incremental pair of 10Mhz OFS channels available to search for noninterfering PCS frequencies vs a single pair (ie 20Mhz) or three pairs (ie 60Mhz). The portion useable by a PCS operator without requiring relocation of OFS users varies significantly from city to city, depends on which 40Mhz, and varies by location within a city. Moreover, it varies depending on the PCS technology's ability to coexist outside an OFS users beampath, and on whether time division or frequency division is employed, even if the PCS allocation is implicitly frequency duplexed.

For simplicity, if we assume for the moment that for any given PCS technology the probability at a given cell site that any 10Mhz OFS channel can be used on a non-interfering basis is the same across all frequencies, then we can gain some idea of how significant in general the ability to search 60Mhz can be for early deployment of PCS.

From Figure 1, we can see that PCS technologies such as Omnipoint's which raise the probability of coexisting in general with OFS users, also increase the value of having more frequencies to choose among for operation at any cell given site. Conversely, non-sharing technologies which have low probabilities of Non-Exclusion in general, still will probably not be able to coexist even with more frequencies to choose from. Thus, providing 60Mhz to hunt over on a cell by cell basis will encourage the use of sharing technologies and further discourage the use of nonsharing technologies.

For example, if the PCS technology can operate close to the microwave link as long as it is outside its beampath and has on average a 60%-80% probability of Non-Exclusion at any given site for any OFS frequency, then going from 20Mhz to 60Mhz to search across (or assuming the paired duplexing scheme, from 10Mhz to 30Mhz in half the band as shown in the Figure 2) raises the overall probability of successful coexistence at a given site to 95-99%. If on the other hand the PCS technology requires large exclusion zones even outside the beampath of a single OFS receiver such that it has only a 10-20% probability of Non-Exclusion on any given frequency, the overall probability of successful coexistence at that site is only raised a to a somewhat futile 28-48%.

Referring to Figure 3, one can see that for a time division duplex scheme that can essentially take advantage of any single available 10Mhz OFS frequency without affecting that OFS frequency's "mate", the advantage of having 60Mhz to search through is overwhelming. In territories with large numbers of microwave links, the average probability of Non-Exclusion will be lower for all PCS technologies due to the large number of beampaths to avoid. But with 60Mhz to search among, even if the average probability of Non-Exclusion is as low as 30% for any OFS frequency, the overall probability of success at coexisting at that site rises to virtually 90%.

The critical issue for PCS to be launched with its full potential is to have a means to coexist in the early years and enough time to negotiate critical relocations.

As discussed above, we firmly believe that PCS needs 40Mhz of clear spectrum per operator to fulfill its promise of offering services significantly different from cellular. We also understand that the Commission favors three PCS licenses per territory in order to ensure competition.

RECOMMENDATION:

We urge the Commission to consider a compromise regarding the amount of spectrum and the number of PCS licenses that takes into consideration the <u>unique requirement facing PCS</u> operators to share spectrum and to make massive infrastructure investments:

- License only two PCS operators per territory initially

- Authorize each PCS operator 40Mhz long term:

  Operator A 1850-1870Mhz and 1930-1950Mhz
  Operator B 1870-1890Mhz and 1950-1970Mhz

- Set aside 1910-1930Mhz for unlicensed uses

- Allow for a period of time equal to the longer of six years from licensing or three years after the start date for involuntary relocation of OFS users, for each of the PCS operators to use <u>temporarily</u> an additional 20Mhz

  Emergency A Band 1890-1900Mhz and 1970-1980Mhz
  Emergency B Band 1900-1910Mhz and 1980-1990Mhz

- These Emergency bands can only be used for cell sites for which the PCS operator cannot use his primary frequencies due to coexistence problems to or from the incumbent OFS users.

- Under no circumstance can the PCS operator use more than 40Mhz in any cell, thus limiting him to only his long term bandwidth capacities from a network architecture.

- At the end of the above six or three year period, the PCS operator must give up any use of the above Emergency bands, and operate only within his designated long term 40Mhz.

The above proposal accomplishes many goals:

1) It gives the Commission the ability to defer judgement on the best use of 40Mhz. Although the two PCS operators will face three other wireless competitors, if after this six year period a third PCS operator is warranted, the Commission can authorize that. In fact, we believe the <u>threat of</u> a third operator will be more beneficial overall in driving the two PCS operators to be aggressive in their infrastructure build out and pricing than would the destructive competitive effects of three operators all trying to reduce their risks by cloning cellular architectures and keeping prices high.

Perhaps a new service will have emerged that has a better claim on the spectrum. In particular, this scheme keeps unallocated all of the 1970-1990Mhz band for the possible licensing to MSS without conflict with any PCS license holders.

2) It provides each PCS operator with the ability to begin operation on a coexistence basis, and gives them time to negotiate relocation agreements or use the involuntary relocation procedures.

3) It provides a PCS operator with the ability to technically differentiate his service from cellular by offering enough near term and long term bandwidth to provide wireline

quality voice, higher per user data rates, lower cost, lighter, longer talk time phones, etc.

4) It gives investors in PCS the confidence to finance the new infrastructures which will provide the ability to drive per minute costs down and allow the use of these improved, lower cost, pocket phones.

5) It minimizes or eliminates the unfair playing field which would otherwise occur among PCS licensees if more than two PCS licenses are awarded, or less than 60Mhz is available per operator to hunt for available frequencies. (Usage in the OFS band is not evenly distributed across the frequencies within any given territory. This is especially true with respect to the frequencies and geographic location of those links which have been permanently grandfathered. Thus, if the frequencies are essentially split as proposed above, the probability of receiving "bad frequencies" is more evenly distributed. With three PCS licenses, by definition at least one will be disadvantaged, and could even be effectively prevented from offering a service if faced with an intractable, permanently grandfathered, incumbent.)

ARGUMENTS AGAINST TWO OPERATORS

Many parties seem to think that licensing more than two operators per territory raises their probability of obtaining a license. We have heard this from some LECs, cellular companies, and small entrepreneurial firms. Unfortunately, if the licenses are awarded by lottery as everyone seems to assume, the number of applications will swamp the slight increase in probability of winning due to there being more licenses per territory. Further, an increase in the number of operators per territory will dramatically diminish the utility of what they could win as well as their ability to raise capital to deploy a service. An auction process would make this abundantly clear, while a lottery process works to foster the wrong goals.

As for the LECs and the cellular operators specifically, which include most of the LECs parent companies, the issue of the number of operators is being confused with the issue of their participation in new spectrum and the competitive aspects of PCS to cellular and the wireline. To see this clearly, take the idea of multiple licenses to its technically impossible extreme: if six 20Mhz operators were proposed so as to allow the cellular carriers and/or LEC's to gain new licenses, the net effect would be to give the cellular operators 45Mhz of "PCS" spectrum (cellular's current 25Mhz plus an additional 20Mhz) and the RBOC's 65Mhz of "PCS" spectrum since the RBOCs are the dominant cellular providers as a group. This would compare to only 20Mhz for the new entrants. From a competitive perspective, this would result in the worst of all possible worlds: the new entrants would be unable to raise the capital or have the bandwidth to provide new services while the existing operators would be able to do so but would not have the incentive.

The Commission should first decide whether to empower PCS to reach its full potential by granting 40Mhz per operator and then decide whether any parties should be prohibited from holding licenses in their existing territories or prohibited for a limited period of time.

"UNIVERSALITY"

We are not sure exactly what is meant by this term as a goal for PCS, especially in light of the fact that it is acknowledged that PCS may result in different services from different operators and mean different things in different territories. The Commission has recognized that PCS will probably begin first in dense urban areas, may provide only islands of coverage or corridors of commuting patterns, and may be targeted heavily at vertical or niche markets initially to survive against cellular's advantages.

PCS is incapable of being built out in many locations let alone deployed everywhere quickly for three reasons:

1) Coexistence requirements with the microwave users will prevent this for purely technical reasons. Most territories will be fortunate if all of the urban area could be built out in the early years given the minimum of three years before fully compensated, involuntary, relocations can occur. In cities like Los Angeles where public safety users own 40% of the links and operate on every frequency, build out will be extremely difficult.

2) For PCS to provide its true benefits, massive fixed cost architectures with relatively small cells must be deployed. It would be catastrophically uneconomic to require microcells everywhere. Building large cells <u>anywhere</u> in the network destroys the ability to use low cost, long talk time, wireline quality handsets. (This is becoming known in the industry as the Gresham's law of RF -- <u>i.e.</u>, high power anywhere drives out the benefits of low power everywhere.)

3) As noted above, PCS by definition may be targeted to geographic or market subsets initially.

Some requirement for build out is necessary to prevent abuse of the license but the requirements will have to take these three issues into consideration, and perhaps vary by territory, each operator's service definition, and frequency allocation.

UNLICENSED SPECTRUM

We concur with the choice of frequencies 1910-1930Mhz but we have three primary concerns:

1) The formulae used on page 72 of the NPRM for calculating spectral efficiency is biased heavily against the two wider band formats, and is especially biased against spread spectrum systems as defined. See Attachment 1, but in summary there would appear to be something unfair about requiring 100Mbps to be delivered in 10Mhz.

2) Unlicensed equipment, by definition, will be owned and operated by independent parties as opposed to single network operators. Thus, unlicensed 10Mhz channels cannot coexist in proximity to one another without significant degradation in throughput. Since the 10Mhz power limits result in the lowest power spectral density, they should be allowed to operate in either of the two 10Mhz channels.

3) Although 1910-1930Mhz is the most lightly loaded portion of the OFS band, there are still over 450 users. Unlicensed PCS equipment, by definition, can be used anywhere, yet the equipment has no way of knowing where it is relative to the 450 beampaths and could thus cause interference even at low power levels. This topic has been discussed and debated vigorously in industry forums for nearly two years and there is almost unanimous agreement that unlicensed applications require national clearing of the bands to prevent interference to the OFS incumbents.

The problem is in finding a solution to who puts up the money and who does the negotiations. Although there have been many proposals, they have all broken down in the details of how to implement them.

Until this critical issue is satisfactorily resolved we cannot endorse the allocation of these frequencies. We recommend that they be set aside for unlicensed use but not allocated until the final mechanism and funding is in place for achieving the national relocations.

Larger Frequency Allocation per Operator Helps Ensure Ability to Find a Frequency In Each Geographic Location

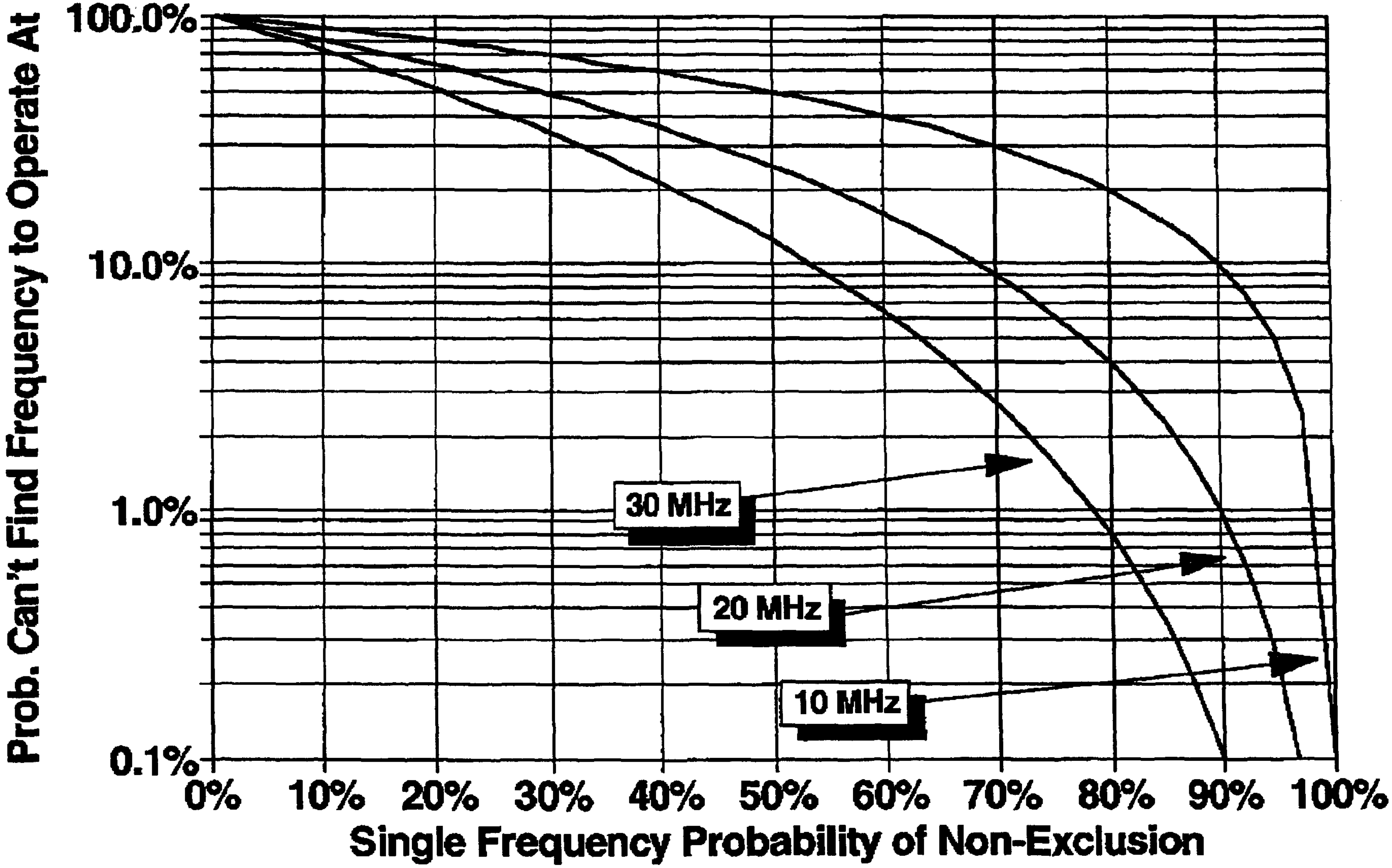


Figure 1

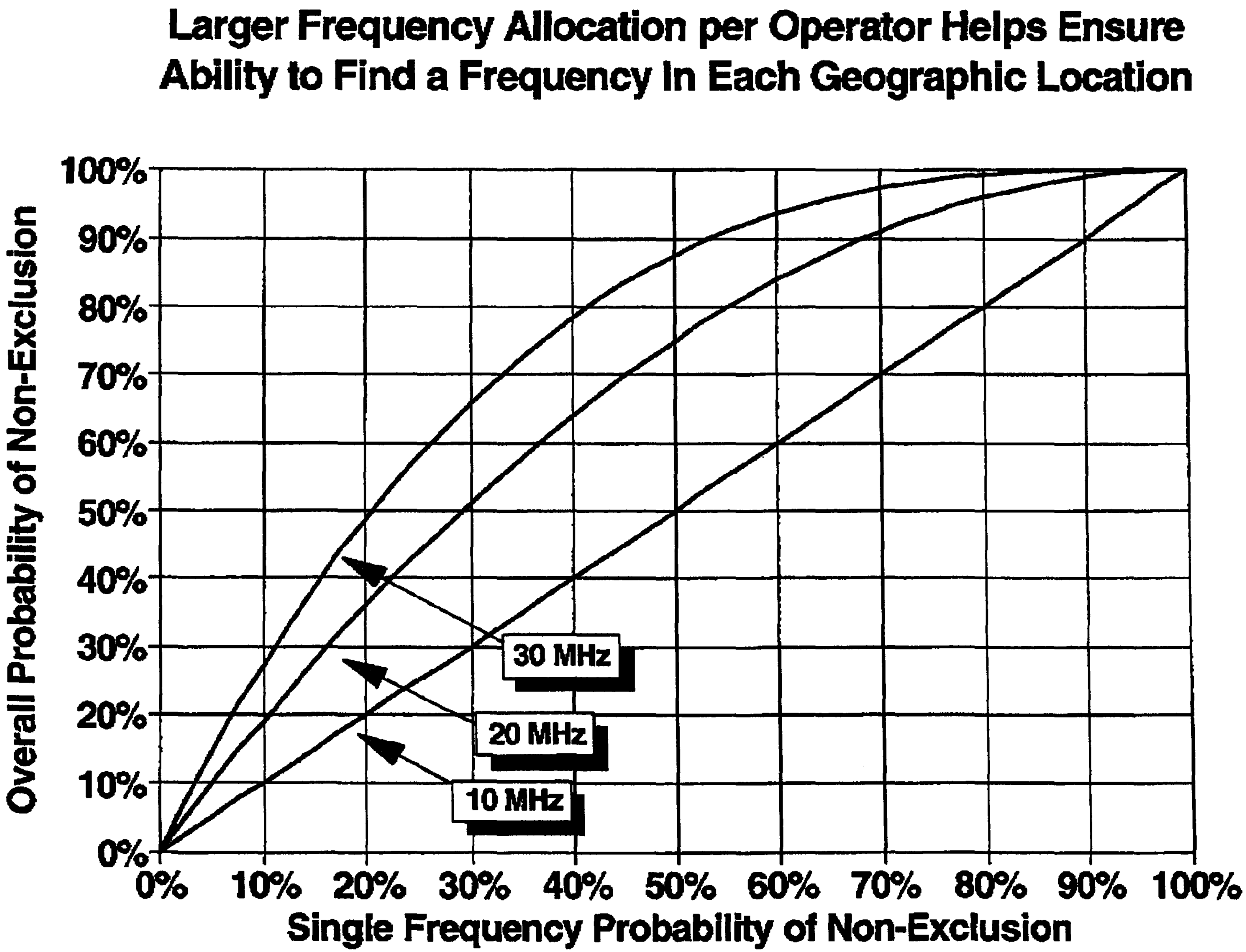
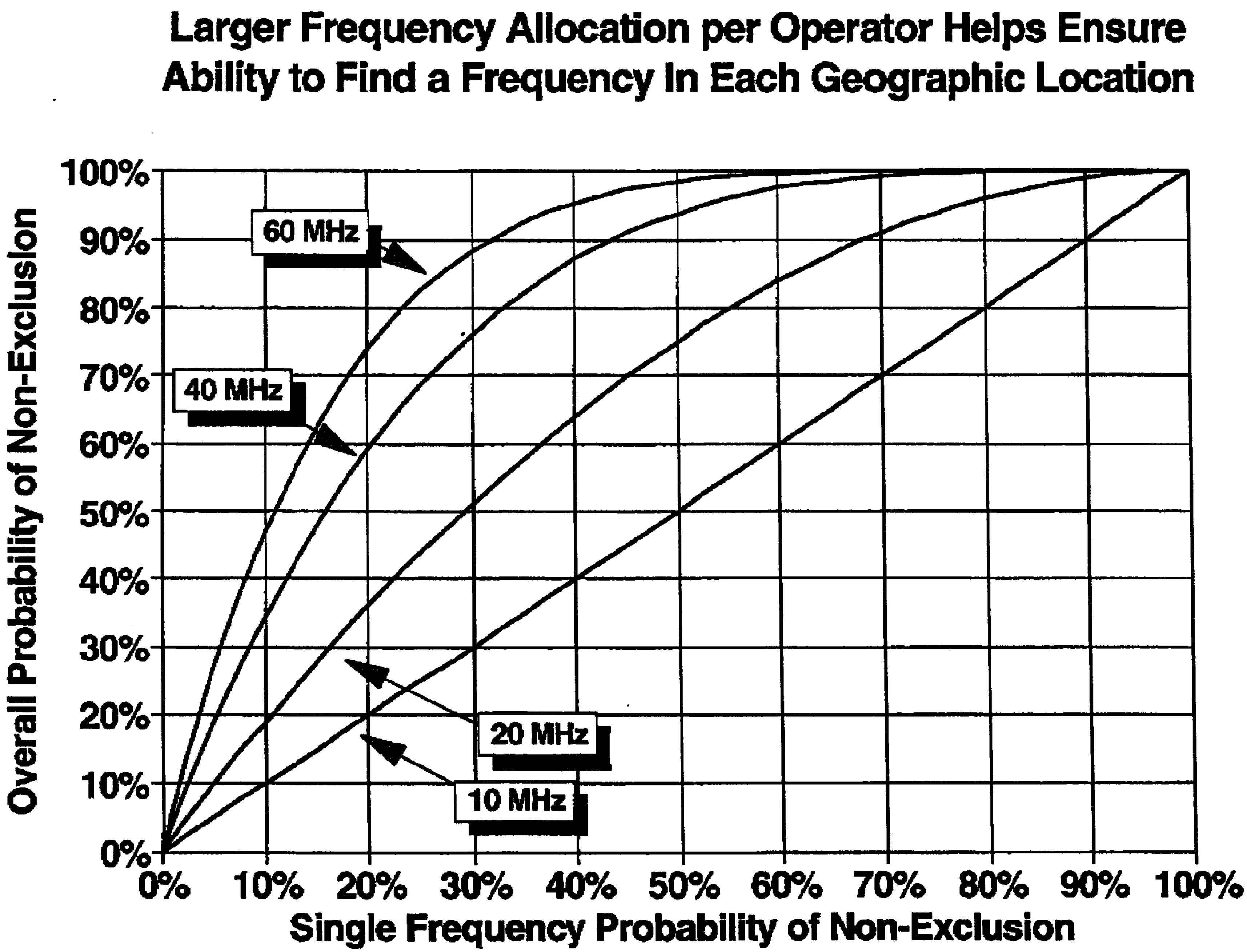

Larger Frequency Allocation per Operator Helps Ensure Ability to Find a Frequency In Each Geographic Location
Overall Probability of Non-Exclusion
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30 MHz
20 MHz
10 MHz
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Single Frequency Probability of Non-Exclusion

Figure 2



Larger Frequency Allocation per Operator Helps Ensure Ability to Find a Frequency In Each Geographic Location
60 MHz
40 MHz
20 MHz
10 MHz
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Overall Probability of Non-Exclusion
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Single Frequency Probability of Non-Exclusion

Figure 3

Attachment I

Applying the spectral efficiency requirements of paragraph (d) on page 72 of the NPRM to the unlicensed systems parameters identified in par. 122[1] of the NPRM; we obtain Table 1 results.

Table 1: Required Spectral Efficiencies

Channel Bandwidth	Peak Power Limit	Power Spectral Density	Required Data Rate per Channel[2]	Required Spectral Efficiency
10 MHz	1 Watt	0.10 Watt/MHz	100 Mbit/sec	10 bit/sec/Hz
1.25 MHz	100 mWatt	0.08 Watt/MHz	1 Mbit/sec	1 bit/sec/Hz
100 kHz	20 mWatt	0.20 Watt/MHz	20 Kbit/sec	0.2 bit/sec/Hz

Examining this table we observe that wideband systems are required to have significantly greater spectral efficiency under the FCC's proposed rules without any corresponding increase in power spectral density allocation. Spectral densities for all three systems are similar; in the neighborhood of 100 mW/MHz.

In principle, as bandwidth increases, more sophisticated error correction encoding algorithms taking advantage of increased dimensionality are theoretically possible. Unfortunately, most such systems are impractical because unrealistically complex encoder/decoder structures are required. Additionally, substantial coding delays are incurred that may not be acceptable in two way communications systems. As written, the spectral efficiency requirement substantially penalizes wideband services by forcing the use of extremely complex and delay prone coding systems.

For these reasons we would argue that whether a system is narrowband or wideband, it's required data rate should be tied only to it's transmit power[3]. Under this supposition, the higher power, wideband services would be required to transmit at higher data rates; meeting the general objectives of the FCC's spectral efficiency requirement.

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[2]Using paragraph (d) minimum requirement.

[3]For a given modulation format; bit error rate is a fixed function of E_b/N_o; the signal to noise ratio per bit. Fixing the value of E_b/N_o, as bandwidth increases; power will also have to increase proportionately. Data rate will also increase proportionate with power.

OTHER REGULATORY ISSUES

We agree with most parties that PCS should be given private carrier status. Speed of deployment is so critical to the success of this industry given cellular's lead.

We also agree with most parties 1) that while national consortiums show a lot of promise, national licenses do not, and 2) that LATA boundaries bring no real benefits and have no correlation with the economic and commuting areas of relevance.

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